

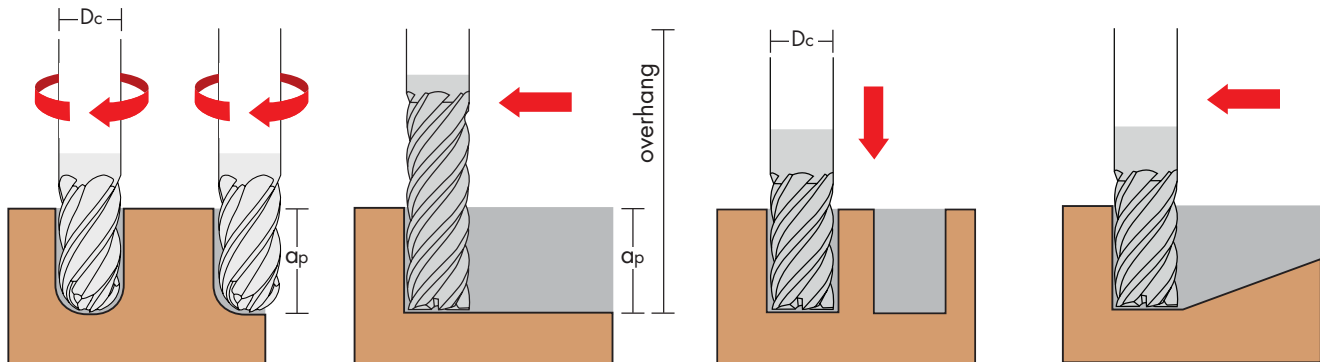
# enDURO® M525 Application Guide • Speed & Feed

ISO Classification	Work Material	Type of Cut	Axial DOC	Radial DOC	Number of Flutes	Speed (M/min)	Feed Rate (MM/min)					
							6,0	10,0	12,0	16,0	20,0	25,0
<b>S</b>	Titanium Alloys 6Al-4V, 6-2-4	Slotting	.5 x D	1 x D	5	76	0.0234	0.0388	0.0467	0.0622	0.0776	0.0935
		Peripheral - Rough	1 x D	.3 x D	5	91	0.0319	0.0529	0.0637	0.0848	0.1058	0.1275
		Peripheral - HEM*	1.5 x D	.1 x D	5	130	0.0609	0.1010	0.1217	0.1619	0.2020	0.2434
		Finish	1.5 x D	.01 x D	5	91	0.0587	0.0975	0.1174	0.1562	0.1949	0.2349
	Difficult to machine titanium alloys 10-2-3	Slotting	.25 x D	1 x D	5	61	0.0173	0.0287	0.0345	0.0459	0.0573	0.0691
		Peripheral - Rough	1 x D	.25 x D	5	76	0.0249	0.0414	0.0499	0.0663	0.0828	0.0997
Peripheral - HEM*		1.5 x D	.1 x D	5	91	0.0450	0.0747	0.0900	0.1196	0.1493	0.1799	
Finish		1.5 x D	.01 x D	5	76	0.0434	0.0720	0.0868	0.1154	0.1441	0.1736	
<b>M</b>	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Slotting	.5 x D	1 x D	5	84	0.0305	0.0506	0.0610	0.0811	0.1012	0.1219
		Peripheral - Rough	1.25 x D	.3 x D	5	107	0.0416	0.0690	0.0831	0.1106	0.1380	0.1663
		Peripheral - HEM*	2 x D	.1 x D	5	145	0.0794	0.1318	0.1588	0.2111	0.2635	0.3175
		Finish	2 x D	.01 x D	5	107	0.0766	0.1271	0.1532	0.2037	0.2543	0.3063
	Precipitation Hardening Stainless Steels 17-4, 15-5, 13-8	Slotting	.5 x D	1 x D	5	76	0.0254	0.0422	0.0508	0.0676	0.0843	0.1016
		Peripheral - Rough	1.25 x D	.3 x D	5	99	0.0346	0.0575	0.0693	0.0921	0.1150	0.1386
Peripheral - HEM*		1.5 x D	.1 x D	5	137	0.0661	0.1098	0.1323	0.1759	0.2196	0.2646	
Finish		1.5 x D	.01 x D	5	99	0.0638	0.1059	0.1276	0.1698	0.2119	0.2553	
<b>P</b>	Low Carbon Steels <= 38 Rc 1018, 1020, 12L14, 5120, 8620	Slotting	.5 x D	1 x D	5	99	0.0356	0.0590	0.0711	0.0946	0.1181	0.1422
		Peripheral - Rough	1.25 x D	.3 x D	5	122	0.0485	0.0805	0.0970	0.1290	0.1610	0.1940
		Peripheral - HEM*	2 x D	.15 x D	5	160	0.0778	0.1292	0.1556	0.2070	0.2583	0.3112
		Finish	2 x D	.01 x D	5	122	0.0893	0.1483	0.1787	0.2377	0.2966	0.3574
	Medium Carbon Steels <= 48 HRC 1045, 4140, 4340, 5140	Slotting	.5 x D	1 x D	5	91	0.0325	0.0540	0.0650	0.0865	0.1079	0.1300
		Peripheral - Rough	1.25 x D	.3 x D	5	114	0.0443	0.0736	0.0887	0.1179	0.1472	0.1774
		Peripheral - HEM*	2 x D	.15 x D	5	152	0.0711	0.1181	0.1423	0.1892	0.2362	0.2845
		Finish	2 x D	.01 x D	5	114	0.0817	0.1356	0.1634	0.2173	0.2712	0.3268
	Tool and Die Steels <= 48 Rc A2, D2, O1, S7, P20, H13	Slotting	.5 x D	1 x D	5	84	0.0274	0.0455	0.0549	0.0730	0.0911	0.1097
		Peripheral - Rough	1.25 x D	.3 x D	5	107	0.0374	0.0621	0.0748	0.0995	0.1242	0.1497
		Peripheral - HEM*	2 x D	.15 x D	5	145	0.0600	0.0996	0.1200	0.1597	0.1993	0.2401
		Finish	2 x D	.01 x D	5	107	0.0689	0.1144	0.1379	0.1833	0.2288	0.2757
Martensitic & Ferritic Stainless Steels 410, 416, 440	Slotting	.5 x D	1 x D	5	91	0.0325	0.0540	0.0650	0.0865	0.1079	0.1300	
	Peripheral - Rough	1.25 x D	.3 x D	5	114	0.0443	0.0736	0.0887	0.1179	0.1472	0.1774	
	Peripheral - HEM*	2 x D	.15 x D	5	152	0.0711	0.1181	0.1423	0.1892	0.2362	0.2845	
	Finish	2 x D	.01 x D	5	114	0.0817	0.1356	0.1634	0.2173	0.2712	0.3268	
<b>K</b>	Cast Iron Gray ASTM-A48 Class 20, 25, 30, 35 & 40	Slotting	.5 x D	1 x D	5	91	0.0305	0.0506	0.0610	0.0811	0.1012	0.1219
		Peripheral - Rough	1.25 x D	.3 x D	5	114	0.0416	0.0690	0.0831	0.1106	0.1380	0.1663
		Peripheral - HEM*	2 x D	.15 x D	5	152	0.0667	0.1107	0.1334	0.1774	0.2214	0.2668
		Finish	2 x D	.01 x D	5	114	0.0766	0.1271	0.1532	0.2037	0.2543	0.3063
	Cast Iron Malleable	Slotting	.5 x D	1 x D	5	84	0.0254	0.0422	0.0508	0.0676	0.0843	0.1016
		Peripheral - Rough	1.25 x D	.3 x D	5	107	0.0346	0.0575	0.0693	0.0921	0.1150	0.1386
		Peripheral - HEM*	2 x D	.15 x D	5	145	0.0556	0.0923	0.1111	0.1478	0.1845	0.2223
		Finish	2 x D	.01 x D	5	107	0.0638	0.1059	0.1276	0.1698	0.2119	0.2553

D = Tool diameter \*HEM= High-efficiency machining

Adjustments  
Reduce feed rates on ball nose mills by 10%  
Reduce speed and feed rates on long length tools by 20%

## Adjustments - Apply these adjustments when programming the following applications.



### 1. Ball nose end mills

- Reduce chip load by 25% from roughing/slotting recommendation when axial DOC (Ap) exceeds 75% of Dc

### 2. Long reach mills with large overhang

- Reduce speed rate and chipload by 10%

### 3. Plunge entry into work piece

- Reduce chipload by 80% of recommended slotting rate
- Peck mill if axial DOC (Ap) exceeds 50% of Dc

### 4. Ramp entry into work piece

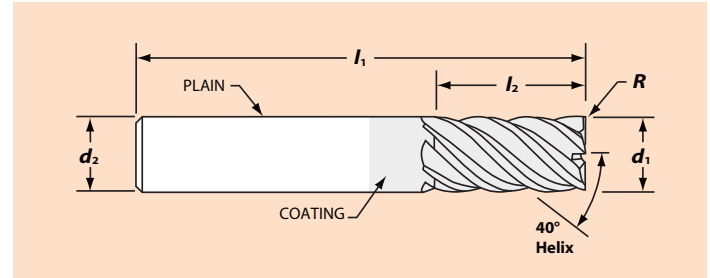
- Ramp at 1.5°-2.5° angle
- Reduce chipload by 20% of recommended slotting rate

# M525

## Square End and Corner Radius



For high performance and high-efficiency machining in materials ranging from titanium to low carbon steels. Large selection of corner radii to meet the demands of today's aerospace industry. Square corner available for general finishing operations and for finishing to a 90° angle.



Use M525 plain shank with milling chuck, collet or shrink-fit tool holders to minimize total indicator runoff (TIR) when performing high-efficiency machining or finishing operations.

### Model Code: M525 w/Square Corner

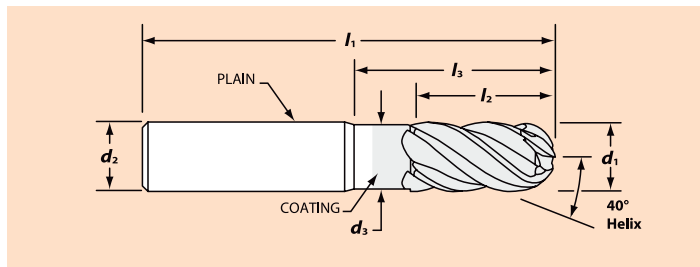
Cutter Dia d1	Shank Dia d2	Length of Cut L2	Overall Length L1	Order Code	EZ-ID Number
					M525-xxx-xxx-SQ d1 L2
6	6	13	57	66655	M525-060-013-SQ
8	8	19	63	66660	M525-080-019-SQ
10	10	22	72	66665	M525-100-022-SQ
12	12	26	83	66671	M525-120-026-SQ
16	16	32	92	66678	M525-160-032-SQ
20	20	38	104	66685	M525-200-038-SQ
25	25	45	120	66693	M525-250-045-SQ

### Model Code: M525 w/Corner Radius

Cutter Dia d1	Shank Dia d2	Length of Cut L2	Overall Length L1	Order Code by Corner Radius (R) (replace -xxx in EZ-ID number with decimal size shown below)								EZ-ID Number	
				0,5	0,75	1,0	1,5	2,0	3,0	4,0	5,0	M525-xxx-xxx-xxx d1 L2 R	
6	6	13	57	66656	66657	66658	66659						M525-060-013-xxx
8	8	19	63	66661	66662	66663	66664						M525-080-019-xxx
10	10	22	72	66666	66667	66668	66669	66670					M525-100-022-xxx
12	12	26	83	66672	66673	66674	66675	66676	66677				M525-120-026-xxx
16	16	32	92		66679	66680	66681	66682	66683	66684			M525-160-032-xxx
20	20	38	104		66686	66687	66688	66689	66690	66691	66692		M525-200-038-xxx
25	25	45	120		66694	66695	66696	66697	66698	66699	66700		M525-250-045-xxx

# M525

## Ball End with Neck Relief



### Model Code: M525N w/Ball End and Neck Relief

Cutter Dia	Shank Dia	Length of Cut	Overall Length	Reach / LBS (specify)	Order Code	EZ-ID Number
d1	d2	L2	L1	L3 max		M525-xxx-xxx-Nxxx-BN-Lxxx d1 L2 L3 L1
6	6	8	63	27 Max	66802	M525-060-008-Nxxx-BN
			75	39 Max	66804	M525-060-008-Nxxx-BN-L75
			100	64 Max	66805	M525-060-008-Nxxx-BN-L100
8	8	10	63	27 Max	66806	M525-080-010-Nxxx-BN
			75	39 Max	66807	M525-080-010-Nxxx-BN-L75
			100	64 Max	66808	M525-080-010-Nxxx-BN-L100
10	10	12	72	32 Max	66809	M525-100-012-Nxxx-BN
			100	60 Max	66810	M525-100-012-Nxxx-BN-L100
			150	110 Max	66812	M525-100-012-Nxxx-BN-L150
12	12	15	83	38 Max	66813	M525-120-015-Nxxx-BN
			100	55 Max	66814	M525-120-015-Nxxx-BN-L100
			125	80 Max	66815	M525-120-015-Nxxx-BN-L125
			150	105 Max	66816	M525-120-015-Nxxx-BN-L150
16	16	20	110	62 Max	66817	M525-160-020-Nxxx-BN
			150	102 Max	66818	M525-160-020-Nxxx-BN-L150
			100	50 Max	66820	M525-200-025-Nxxx-BN
20	20	25	125	75 Max	66821	M525-200-025-Nxxx-BN-L125
			150	100 Max	66822	M525-200-025-Nxxx-BN-L150
			120	64 Max	66823	M525-250-032-Nxxx-BN
25	25	32	150	94 Max	66824	M525-250-032-Nxxx-BN-L150

Minimizes tool deflection and increases productivity when contouring deep cavities.

## PROFILE:

IMCO Sales Representative  
**Russ Johnson**

Russ Johnson's 20-year history as a CNC programmer is a benefit to his customers. Jim O'Leary with **Bob's Design Engineering** knows it well. A progressive R&D prototype machine shop, Bob's Design does a lot of high-speed/high-performance tool testing.

When they tested enDURO® tools against two others in 316 stainless steel, everyone was astounded.



### The results

- 570% longer tool life (175 parts per tool to 1000)
- 600% increase in cubic inches of material removed
- Average of 10% to 40% reduction in cycle time

Working in stainless steel may not typically bring smiles, but it does now for Tool Engineer Jim O'Leary (left), Programmer/machinist Jeremie Groshong (center) and IMCO Representative Russ Johnson at Bob's Design Engineering.

## Model Code: M525N w/Square Corner and Neck Relief

Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Reach / LBS (specify) l3 max	Order Code	EZ-ID Number
						M525-xxx-xxx-Nxxx-SQ-Lxxx d1 l2 l3 l1
6	6	8	63	27 Max	66701	M525-060-008-Nxxx-SQ
			75	39 Max	66706	M525-060-008-Nxxx-SQ-L75
			100	64 Max	66711	M525-060-008-Nxxx-SQ-L100
8	8	10	63	27 Max	66716	M525-080-010-Nxxx-SQ
			75	39 Max	66721	M525-080-010-Nxxx-SQ-L75
			100	64 Max	66727	M525-080-010-Nxxx-SQ-L100
10	10	12	72	32 Max	66733	M525-100-012-Nxxx-SQ
			100	60 Max	66740	M525-100-012-Nxxx-SQ-L100
			150	110 Max	66747	M525-100-012-Nxxx-SQ-L150
12	12	15	83	38 Max	66754	M525-120-015-Nxxx-SQ
			100	55 Max	66761	M525-120-015-Nxxx-SQ-L100
			125	80 Max	66768	M525-120-015-Nxxx-SQ-L125
			150	105 Max	66775	M525-120-015-Nxxx-SQ-L150
16	16	20	110	62 Max	66782	M525-160-020-Nxxx-SQ
			150	102 Max	66789	M525-160-020-Nxxx-SQ-L150
20	20	25	100	50 Max	66796	M525-200-025-Nxxx-SQ
			125	75 Max	66803	M525-200-025-Nxxx-SQ-L125
			150	100 Max	66811	M525-200-025-Nxxx-SQ-L150
25	25	32	120	64 Max	66819	M525-250-032-Nxxx-SQ
			150	94 Max	66827	M525-250-032-Nxxx-SQ-L150

## WHAT'S THE REACH?

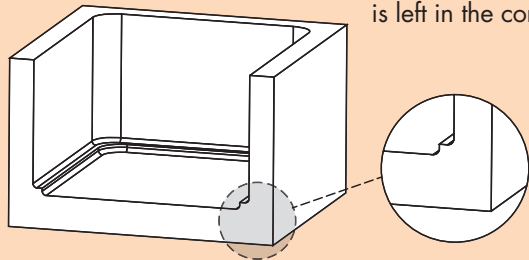
Every job is different. When ordering an M525 with neck relief, be sure to indicate the desired reach (also called Length Below Shank) dimension you need. The charts on this page indicate the maximum LBS dimension possible for every tool. Simply order by EZ-ID code to specify the dimensions you need. See page 15 to learn how the EZ-ID system works.

## Model Code: M525N w/Corner Radius and Neck Relief

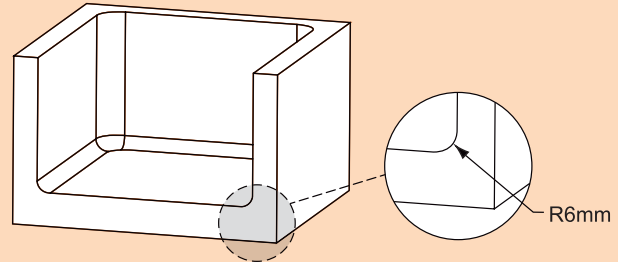
Cutter Dia d1	Shank Dia d2	Length of Cut l2	Overall Length l1	Reach / LBS (specify) l3 max	Order Code by Corner Radius (R) (replace -xxx in EZ-ID number with decimal size shown below)							EZ-ID Number	
					0,5	1,0	1,5	2,0	3,0	4,0	5,0	M525-xxx-xxx-Nxxx-xxx-Lxxx d1 l2 l3 R l1	
6	6	8	63	27 Max	66835	66843	66851						M525-060-008-xxx
			75	39 Max	66859	66867	66702						M525-060-008-xxx-L75
			100	64 Max	66703	66704	66705						M525-060-008-xxx-L100
8	8	10	63	27 Max	66707	66708	66709						M525-080-010-xxx
			75	39 Max	66710	66712	66713						M525-080-010-xxx-L75
			100	64 Max	66714	66715	66717						M525-080-010-xxx-L100
10	10	12	72	32 Max	66718	66719	66720	66722					M525-100-012-xxx
			100	60 Max	66723	66724	66725	66726					M525-100-012-xxx-L100
			150	110 Max	66728	66729	66730	66731					M525-100-012-xxx-L150
12	12	15	83	38 Max	66732	66734	66735	66736	66737				M525-120-015-xxx
			100	55 Max	66738	66739	66741	66742	66743				M525-120-015-xxx-L100
			125	80 Max	66744	66745	66746	66748	66749				M525-120-015-xxx-L125
			150	105 Max	66750	66751	66752	66753	66755				M525-120-015-xxx-L150
16	16	20	110	62 Max		66756	66757	66758	66759	66760			M525-160-020-xxx
			150	102 Max		66762	66763	66764	66765	66766			M525-160-020-xxx-L150
20	20	25	100	50 Max		66767	66769	66770	66771	66772	66773		M525-200-025-xxx
			125	75 Max		66774	66776	66777	66778	66779	66780		M525-200-025-xxx-L125
			150	100 Max		66781	66783	66784	66785	66786	66787		M525-200-025-xxx-L150
25	25	32	120	64 Max		66788	66790	66791	66792	66793	66794		M525-250-032-xxx
			150	94 Max		66795	66797	66798	66799	66800	66801		M525-250-032-xxx-L150

# How to Finish a Fillet Radius with the Blender™ Mill

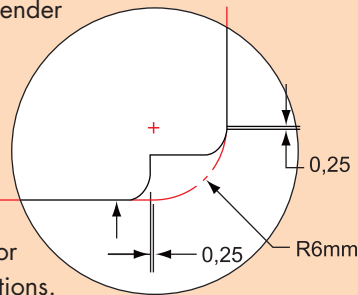
**Step 1** In this example, the part requires a pocket with a .6,5mm fillet radius. Using constant radial engagement, the pocket is roughed out, and the walls and floors are finished using a series of M525 enDURO® end mills. Note that a controlled amount of material is left in the corner.



**Step 3** Starting at the floor depth, the stepover on the first pass is set at 25% of the mill diameter. The stepover on the second pass is made at the final fillet dimension. The Blender mill leaves no witness marks on the floor or walls.



**Step 2** Finishing passes on the walls and floors are stopped 0,25mm from the tangent points of the 6mm radius. The Blender mill will be used to rough and finish the fillet. Its exclusive design eliminates unnecessary flute length, increasing core strength and giving the tool superior rigidity for these deep reach applications.



**FLOOR FINISHING OPTION:** The unique geometry of the Blender mill gives you the option of finishing the floor as well as the fillet radius. Leave 0,125mm–0,4mm of stock on the floor depending on the material (see chart below) and step over 25% of the mill's diameter per pass. Use the same speed and feed rates to finish both floor and fillet radius.

## Blender Mill Application Guide • Speed & Feed

ISO Classification	Work Material	Type of Cut	Axial DOC (mm)	Radial DOC	Number of Flutes	Speed (SFM)	Feed (Inches per Tooth)				
							10,0	12,0	16,0	20,0	25,0
<b>S</b>	Titanium Alloys 6Al-4V, 6-2-4	Floor Finishing	0,125 - 0,180	.25 x D	5	76	0,0511	0,0616	0,0819	0,1022	0,1232
		Fillet Radius Finishing	Final floor depth	See below*	5	76	0,0511	0,0616	0,0819	0,1022	0,1232
	Hi-Temp Alloys Inconel, Hastelloy	Floor Finishing	0,125 - 0,180	.25 x D	5	46	0,0560	0,0675	0,0897	0,1120	0,1349
		Fillet Radius Finishing	Final floor depth	See below*	5	46	0,0560	0,0675	0,0897	0,1120	0,1349
<b>M</b>	Austenitic Stainless Steels, FeNi Alloys 303, 304, 316, Invar, Kovar	Floor Finishing	0,125 - 0,250	.25 x D	5	91	0,0511	0,0616	0,0819	0,1022	0,1232
		Fillet Radius Finishing	Final floor depth	See below*	5	91	0,0511	0,0616	0,0819	0,1022	0,1232
	Precipitation Hardening Stainless Steels 17-4, 15-5, 13-8	Floor Finishing	0,125 - 0,250	.25 x D	5	91	0,0536	0,0645	0,0858	0,1071	0,1290
		Fillet Radius Finishing	Final floor depth	See below*	5	91	0,0536	0,0645	0,0858	0,1071	0,1290
<b>P</b>	Martensitic & Ferritic Stainless Steels 410, 416, 440	Floor Finishing	0,125 - 0,400	.25 x D	5	91	0,0560	0,0675	0,0897	0,1120	0,1349
		Fillet Radius Finishing	Final floor depth	See below*	5	91	0,0560	0,0675	0,0897	0,1120	0,1349
	Tool and Die Steels A2, D2, O1, S7, P20, H13	Floor Finishing	0,125 - 0,400	.25 x D	5	91	0,0536	0,0645	0,0858	0,1071	0,1290
		Fillet Radius Finishing	Final floor depth	See below*	5	91	0,0536	0,0645	0,0858	0,1071	0,1290

### TOOL TIPS:

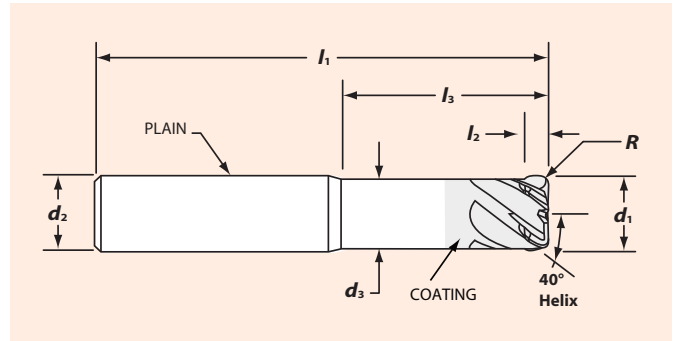
- \* Radial cut guide for finishing fillet radii: **First pass** = Max radial cut of .25 x mill diameter, leaving 0,25mm on wall; **Second pass** = Remove the final 0,25mm of material; **Third pass (if needed)** = Run a "spring" pass to ensure finish and fillet dimensional accuracy.
- Reduce speed and feed rates by 20% when your tool has an overall length greater than 10x the diameter.
- Rough the part to +0,25mm above and adjacent to the fillet radius.
- Maintain a total indicator runout (TIR) <0,015mm for maximum tool life and a superior surface finish.
- Using a tool radius smaller than the fillet radius will require extra passes.

# M525

## Blender™ Mill



Use the M525EB Blender mill for fast blending of fillets to walls and floors without leaving witness marks. The Blender mill is also used in conjunction with high-efficiency machining techniques to achieve an unsurpassed floor finish.



### Model Code: M525EB enDURO Blender Mill

Cutter Dia d1	Shank Dia d2	Length of Cut l2	LBS l3	Overall Length l1	Order Code by Corner Radius (R)								EZ-ID Number			
					(replace -xxx in EZ-ID number with decimal size shown below)								M525-xxx-EB20-Nxxx-xxx			
					1,5	2,0	3,0	4,0	5,0	6,0	9,5	d1	l2	l3	R	
10	10	2 x R	60	100	68900	68901	68902	68903				M525-100-EB20-N060-xxx				
		2 x R	85	125	68904	68905	68906	68907				M525-100-EB20-N085-xxx				
		2 x R	110	150	68908	68909	68910	68911				M525-100-EB20-N110-xxx				
12	12	2 x R	55	100	68912	68913	68914	68915	68916			M525-120-EB20-N055-xxx				
		2 x R	80	125	68917	68918	68919	68920	68921			M525-120-EB20-N080-xxx				
		2 x R	105	150	68922	68923	68924	68925	68926			M525-120-EB20-N105-xxx				
16	16	2 x R	52	100	68927	68928	68929	68930	68931	68932		M525-160-EB20-N052-xxx				
		2 x R	77	125	68933	68934	68935	68936	68937	68938		M525-160-EB20-N077-xxx				
		2 x R	102	150	68939	68940	68941	68942	68943	68944		M525-160-EB20-N102-xxx				
20	20	2 x R	54	104	68945	68946	68947	68948	68949	68950		M525-200-EB20-N054-xxx				
		2 x R	75	125	68951	68952	68953	68954	68955	68956		M525-200-EB20-N075-xxx				
		2 x R	100	150	68957	68958	68959	68960	68961	68962		M525-200-EB20-N100-xxx				
25	25	2 x R	64	120	68963	68964	68965	68966	68967	68968	68969	M525-250-EB20-N064-xxx				
		2 x R	94	150	68970	68971	68972	68973	68974	68975	68976	M525-250-EB20-N094-xxx				